0 3 This question is about oxygen.

0 3 . 1 Hydrogen reacts with oxygen.

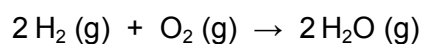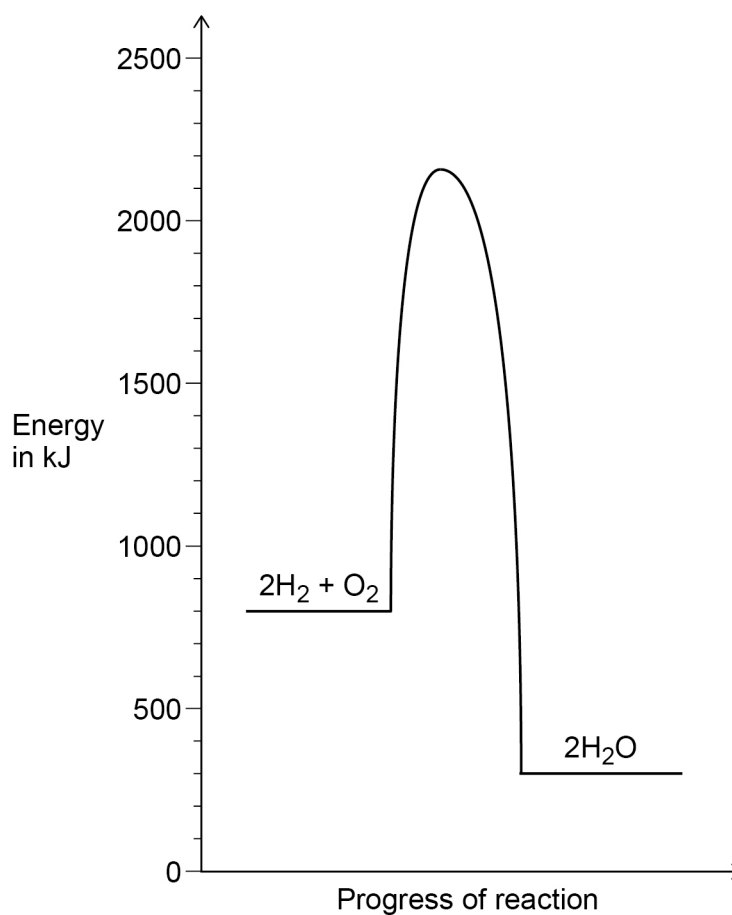$$2 H_2 (g) + O_2 (g) \rightarrow 2 H_2O (g)$$

Figure 2 shows the relative energies of the reactants and products at a certain temperature.

Figure 2

Label the activation energy on **Figure 2**.

[1 mark]

| 0 | 3 | . | 2 | Determine the overall energy change for the reaction between hydrogen and oxygen shown in Question **03.1**

Use **Figure 2**.

[2 marks]
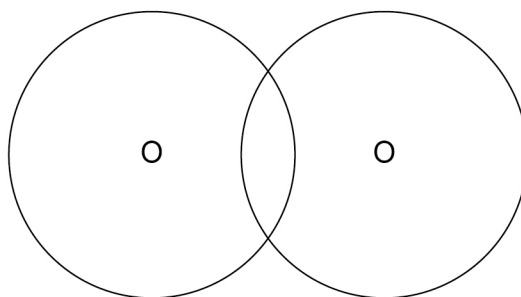
Energy change = _____ kJ

| 0 | 3 | . | 3 | Oxygen is in Group 6 of the periodic table.

Figure 3 shows the outer energy levels in one molecule of oxygen (O_2).

Draw the electrons in the outer energy levels in **Figure 3**.

[2 marks]

Figure 3

O   O

Question 3 continues on the next page

Turn over ▶

0 3 . 4 The equation shows the decomposition of hydrogen peroxide.

$$2\ H–O–O–H \rightarrow 2\ H–O–H\ +\ O=O$$

Table 1 shows the bond energies.

Table 1

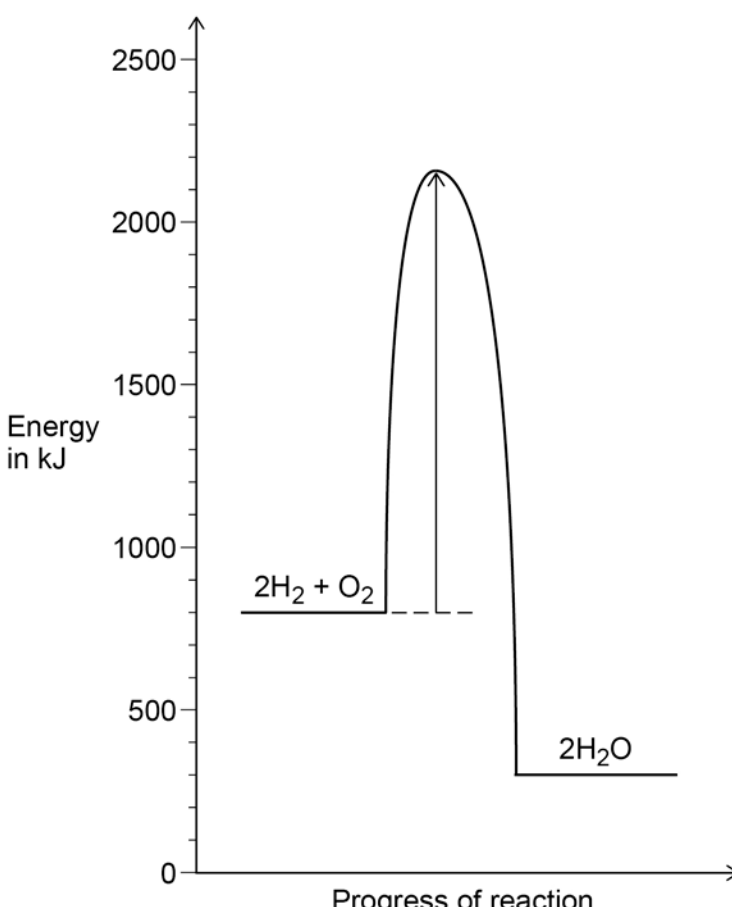| Bond	O–O	O=O	O–H
Bond dissociation energy in kJ per mole	138	496	463

Calculate the overall energy change for the reaction.
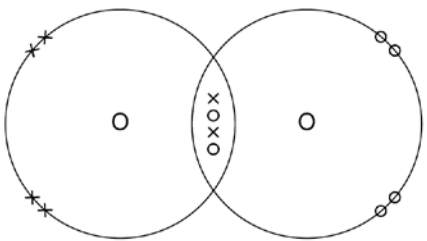
[3 marks]

Energy change = _____ kJ

8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	line from reactants to top of curve (i.e. from 800 to 2160) ignore arrowheads		1	AO1 5.5.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2		an answer of (–) 500 (kJ) scores **2** marks ignore sign		AO2 AO3 5.5.1.2
	reads levels of reactants (800 kJ) and products (300 kJ)		1	
	(800 – 300) = 500 (kJ)	allow correct subtraction of one incorrect value determined for the energy change	1	

03.3		allow combination of circles, dots, crosses or e$^{(-)}$		AO2 5.2.1.4
	two shared pairs in overlap		1	
	all non-bonding electrons in outer shell (4 electrons on each O atom)	ignore any inner shell electrons	1	
		diagram scores 2 marks		

03.4		an answer of (–) 220 (kJ) scores **3** marks an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps		AO2 5.1.1.1 5.5.1.1 5.5.1.3
	(bonds broken) ((4×463) + (2×138) =) **2128**		1	
	(bonds made) ((4×463) + (496) =) **2348**		1	
	(energy change = bonds broken – bonds made) (2128 – 2348 =) (–) **220** (kJ)		1	
		ignore energy change sign allow correct calculation using incorrect values from step 1 and/or step 2		
	alternative approach: (bonds broken) (2× (O–O) = (2×138) =) **276** (1) (bonds made) (1× (O=O) =) **496** (1) (energy change = bonds broken – bonds made) (276 – 496 =) (–) **220** (kJ) (1)			

Total			8	